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IMPACTS OF TECHNOLOGICAL CHANGES IN WAREHOUSING, PHASE I.

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DESCRIPTORS- *FEASIBILITY STUDIES, *TECHNOLOGICAL ADVANCEMENT, *WAREHOUSES, *EMPLOYMENT PROBLEMS, AUTOMATION, MARKETING, CALIFORNIA, OREGON, WASHINGTON, HAWAII, ALASKA,

THE OBJECTIVES OF THIS STUDY WERE (1) TO DETERMINE THE AVAILABILITY, NATURE, AND RELIABILITY OF DATA ON THE RAPID CHANGE IN THE WAREHOUSING FUNCTION IN INDUSTRY AND (2) TO PROVIDE A BASIS FOR DECISIONS CONCERNING THE DESIRABILITY AND FEASIBILITY OF CONDUCTING SUBSEQUENT STUDIES. THREE MAJOR SOURCES OF INFORMATION ON CALIFORNIA, OREGON, WASHINGTON, HAWAII, AND ALASKA WERE INVESTIGATED--GENERAL LITERATURE, INTERVIEWS WITH KNOWLEDGEABLE PERSONS, AND FIELD STUDIES OF WAREHOUSES. IT WAS CONCLUDED THAT MECHANIZATION OF WAREHOUSING IN THE FIVE-STATE REGION WOULD PROCEED AT A GRADUAL PACE, BUT HISTORICALLY THIS PACE HAD NOT RESULTED IN SIGNIFICANT DISEMPLOYMENT OF THE WAREHOUSE LABOR FORCE. IT WAS RECOMMENDED THAT (1) THE FULL-SCALE NATIONWIDE PHASE II STUDY NOT BE DONE AT THIS TIME, (2) A STUDY BE CONDUCTED WHICH WOULD IDENTIFY RAPIDLY CHANGING WAREHOUSING, MAKE A DEFINITIVE INVENTORY OF CURRENT WAREHOUSING TECHNOLOGY, AND DEVELOP METHODS OF RELATING TECHNOLOGICAL CHANGE TO ITS EFFECTS ON LABOR, (3) AN EXPLORATORY STUDY OF THE APPARENT TREND TO CENTRALIZATION OF WAREHOUSING FUNCTIONS BE CONSIDERED, AND (4) A RECONNAISSANCE STUDY OF THE WAREHOUSE ASPECTS OF THE WHOLESALE AND MULTIPLE OUTLET RETAIL FOOD INDUSTRY BE CONSIDERED. (EM)

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Phase I

# IMPACTS OF TECHNOLOGICAL CHANGES IN WAREHOUSING

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SRI Project IU-5534

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# I INTRODUCTION

In late 1964 Stanford Research Institute submitted a proposal to the Office of Manpower, Automation and Training (OMAT) for a comprehensive, nationwide study of the impacts of technological change in warehousing operations. This proposal was based on previous studies* and on information indicating the possibility of rather rapid change in the technology of the warehousing function in industry. An overall study seemed both timely and advisable because of the potential impact of technological change on the warehousing labor force.

In subsequent discussions, OMAT and SRI representatives agreed that the study could be useful to the Department of Labor in anticipating technological changes in the economy and predicting their impacts on employment. They also concluded that certain difficulties, such as data availability and collection procedures, might create major methodological problems. Therefore, it was agreed that any nationwide study should be preceded by an exploratory study of modest scope, so designed that the feasibility of more ambitious work could be established. In accordance with the limited contractual requirement this report has been prepared for OMAT to describe the results of this first phase exploratory study.

## Objectives

In keeping with the limited scope of the feasibility study, the specific objectives were:

1. To determine the availability, nature, and reliability of required data.

2. To provide a basis for decisions concerning the desirability and feasibility of conducting subsequent studies.

## Scope

The study covered the five-state western region of the United States--California, Oregon, Washington, Hawaii, and Alaska.† This region conforms to the area of responsibility of OMAT's Pacific Coast Regional

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* One Institute study included four intensive case studies of warehouse change: R. S. Roberts, Management Decisions to Automate (final project report to OMAT), Stanford Research Institute, May 1964.

† Field visits were made to all states except Alaska.

Manpower Advisory Committee. With the exception of military and government installations, all classes of warehouses were considered--distribution warehouses, manufacturers' warehouses, public warehouses, and transfer terminals.

Emphasis was on workers participating in warehousing functions and those in direct support of these functions. The study did not include administrative personnel and other employees indirectly related to warehousing.

Research was restricted to the movement and storage of finished products, i.e., materials handled in a solid state. Handling of gaseous, liquid, or semisolid materials (e.g., chemicals, petroleum, grain) was excluded from the study.

Primary attention was given to warehouse mechanization. Related factors likely to affect warehousing functions and employment (e.g., centralization, management policies, labor relations) were also considered.

## Method of Approach

Three major sources of information were investigated:

1. The general literature, including technical books and articles, popular and semipopular publications, and statistical materials (published and unpublished).

2. Interviews with knowledgeable persons (e.g., government experts, management and union representatives, equipment suppliers, and engineering consultants).

3. Field study of warehouses. (A list of persons interviewed and warehouses surveyed is given in Appendix A.)

Investigation of warehouses proceeded on a selective basis. Initially, the project staff worked in the San Francisco Bay area; later, visits were made to the major cities of the western region. It soon became evident that certain classes of warehouses were not likely candidates for technological change because of such factors as size, type, and volume of goods handled. Accordingly, it was possible to be more selective in the choice of warehouses to investigate.

## Acknowledgements

Great appreciation is due to the many people who cooperated in this study and who gave freely of their time and knowledge. The following persons were especially helpful in providing information or in reviewing the draft report: Andrew Briggs, Lincoln Fairley, John Furrer, Bernard Knill, Bruce Poyer, Ronald Ray, John Sheahan, R. C. Sollenberger, John Stevens, Gordon Thomas, Jack Timmer, and Howard Werle.

OMAT staff members assisted the SRI staff throughout the study, and Harry Bonfils, the OMAT Project Monitor, was particularly helpful.

The project team also received valuable advice from Institute colleagues, particularly Don Woodworth, Paul Jones, and Edward Jacobs.

## II CONCLUSIONS AND RECOMMENDATIONS

### Conclusions

1. This preliminary study shows that definitive studies are necessary to develop primary data (a) to identify warehouses that are adopting automation and mechanization; and (b) to survey and study all, or a sample of such warehouses to measure the extent of technological change and its impact on employment. Current information for these purposes is inadequate for identifying either the population of warehouses or the warehousing labor force. No methods exist for enumerating various classes of mechanized warehouses, since most installations fall between the two extremes of manual or highly mechanized operations. Only by breaking down the overall system into its unit functions can the degree of technological change be identified. Consequently, a study in depth of the degree to which mechanization has penetrated warehousing functions would require techniques similar to those developed by Professor James Bright in his profile of mechanization.

2. Identifying warehouses of interest in any future definitive study could be accomplished by such methods as: (1) a survey of manufacturers, wholesalers, or multiple outlet retailers listed in existing directories (e.g. Thomas Wholesale Grocery and Kindred Trades Register); (2) enumeration procedures similar to those used by the Bureau of the Census. Although the present study has indicated that cooperation can be expected from management, it has also indicated that the information derived from management is highly variable in quality and inclusiveness.

3. Identifying all U.S. warehouses and studying them in the depth required to relate technological change to changes in employment would require extremely large amounts of time and funds. Information developed in this exploratory study suggests that, with some exceptions, the pace of technological change is not rapid enough to justify a nationwide study of all warehouses. Therefore, it is concluded that a large-scale nationwide study as originally considered for Phase II of this research is neither economically feasible, nor useful to the purposes and responsibilities of OMAT.

4. Certain trends indicate the possibility of rapid change in warehousing in some industries. In particular, warehouses associated with the wholesale and multiple outlet retail food industry appear subject to more accelerated change than do others. Warehouses in such industries as food processing, printing and publishing, metal and metal products, drug and toilet articles, apparel and dry goods, and alcoholic beverages also appear to

be likely candidates for change. It is not possible to predict if this change, assuming it materializes, would have a significant effect on employment.

5. There is considerable evidence of an increasing tendency to replace small, widely scattered warehouses with larger, centralized warehouses (often called distribution centers or distribution warehouses). Centralization could speed up the adoption of mechanization, since it establishes warehouses of sufficient size and volume of goods handled to warrant the change. No conclusive evidence was found concerning the employment effects of this development; however, the elimination of many small warehouses suggests that substantial numbers of employees are affected.

6. Preliminary data for the San Francisco Bay Area, developed from labor union sources, indicate that the majority of warehouses are small, in terms of numbers of employees. Small warehouses appear to be unable to afford significant mechanization.

7. The findings of this study suggest that mechanization of warehousing in the five-state western region will proceed at a gradual pace. Historically, this pace has not resulted in significant disemployment of the warehouse labor force.

## Recommendations

1. The full-scale nationwide Phase II study of the impacts of technological change is not recommended at this time. However, recommendations are given below for less comprehensive research that might be warranted now.

2. Warehouses in general appear to be changing their technology at a slow pace. Yet in a time when innovations in technology are routine, it may be advisable to monitor certain aspects of the warehousing scene. A reasonable first step might be an exhaustive study of the relationships between changes in technology and the labor force in a sample of geographical areas that is representative of the United States as a whole. Such a study would establish:

   a. The classes of warehousing that are changing most rapidly.

   b. A definitive inventory of the current technology employed in warehouses.

   c. Methods for relating technological change to its effects on labor.

3. An exploratory study of the apparent trend to centralization of warehousing functions might be warranted, in order to determine if this trend is affecting employment significantly.

4. A reconnaissance study of the warehouse aspects of the wholesale and multiple outlet retail food industry might also be warranted at this time. Such a study should establish if the indicated trends to mechanization are likely to have a significant impact on employment.

## III NATURE AND AVAILABILITY OF PRIMARY WAREHOUSING DATA

Initial Bay Area explorations of federal, state, and county sources of information indicate that a body of information on warehousing and its labor force, similar to that found under SIC classifications for other industries, does not exist. The only comprehensive information concerns public warehouses.* Available information related to the warehousing labor force is found in the Census of Population† and in the Occupational Wage Survey of the Bureau of Labor Statistics.‡ Although these sources report the number of persons employed in such typical warehouse occupations as laborer, order-filler, and packer, the coverage includes non-warehouse employees as well. Consequently, these data are of little assistance in the current research.

Efforts were made to obtain information from the general literature, government agencies, trade and employer associations, labor unions, and individuals and organizations supplying equipment or services to the warehousing function. These sources are of limited use in identifying the population of warehouses or the warehouse labor force, but they are valuable in providing background information, identifying trends in warehousing, and developing hypotheses concerning technological change and effects on employment.

### The Literature on Warehousing

The general literature related to warehousing, covering the period from 1955 to 1965, was reviewed. Sources of information include such publications as: American City, Aviation Week and Space Technology, Automation, Business Week, Chain Store Age, Computers and Automation, Distribution Age, Dun's Review and Modern Industry, Factory, Fleet Owner, Fortune, Iron Age, Materials Handling Engineering, Modern Materials Handling, Paper Trade Journal, Printer's Week, Publisher's Weekly,

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* See, for example, 1963 Census of Business, Wholesale Trade, BC 63-WS-10, Public Warehousing, 1965; and Distribution Age, Warehouse Directory, Chilton Company, Philadelphia, 1965.

† U.S. Dept. of Commerce, Bureau of the Census, 1960 Census of Population, Classified Index of Occupations and Industries.

‡ U.S. Dept. of Labor, "Wages and Related Benefits," Bureau of Labor Statistics, Bulletin No. 1303-83, Part II: Metropolitan Areas, U.S. and Regional Summaries, 1961-62 (May 1963).

Progressive Grocer, Railway Age, Steel, and Western Materials Handling. Editorial staff members on four of these publications were also consulted.

## Government Agencies

The Santa Clara County Tax Assessor's Office and the County Planning Department produced minimal information. Assessment rolls, described as a potential means for identification of local warehouses, are of value only in identifying public warehouses. Land-use studies, conducted by a county planning group, have no direct applicability to the study.

Other local agencies, such as the California State Departments of Employment and of Industrial Relations, the California Public Utilities Commission, and regional offices of the U.S. Bureau of Labor Statistics and U.S. Bureau of Employment Security have no information relevant to this study.

Informative discussions with such agencies as the Oregon State Department of Planning and Economic Development and the Hawaii State Department of Land and Natural Resources developed many promising leads, but in general the data available from these agencies are fragmentary.

A special visit was made to the Occupational Analysis Field Center (Bureau of Employment Security) in Los Angeles--one of seven such branches established by the Bureau of Employment Security in 1959 to develop information for a new edition of the Dictionary of Occupational Titles (DOT). A comparison of page proofs for the "Packaging and Materials Handling Occupations" section of the revised DOT with the previous edition revealed no significant exclusions. It therefore does not appear that any job classifications have become obsolete.

## Trade Associations

Discussions were held with the following associations in warehousing and related fields: American Warehousemen's Association, Conveyor Equipment Manufacturers' Association, Materials Handling Institute, National Motor Freight Traffic Association, National Association of Refrigerated Warehouses, National Association of Food Chains, National Wholesale Druggists' Association, United States Wholesale Grocers' Association, Inc., and Western Association of Food Chains. These associations have no statistics on the warehousing labor force within the industries they represent, but are extremely valuable in identifying trends in warehousing by industry, and in providing an overall view of the impact of mechanization on their representative industries for the national scene.

## Employer Associations

Employer associations generally have information only on those firms that are association members. Primarily, these groups handle contractual

relations between employers and labor unions. However, the Distributors' Association of Northern California, the administering body for labor union pension fund agreements, did provide useful listings of firms with warehousemen covered by these agreements.

## Labor Unions

Interviews were held with officials of both the International Brotherhood of Teamsters (IBT) and the International Longshoremen's and Warehousemen's Unions (ILWU) to discuss the information potentially available from their surveys and membership rolls.

The Labor-Management Reporting and Disclosure Act, generally known as the Landrum-Griffin Act, requires that reports on pension fund accounts be submitted annually to the federal government and that such reports be public information. Copies of pension fund listings were obtained that are particularly useful to the purposes of this study. Although these listings are not exhaustive, officials of both the IBT and the ILWU have estimated that a combination of these lists would include 90 percent of the employed warehousemen in the area under their jurisdiction. The remaining 10 percent are accounted for by a scattering of very small non-union operations.

The listing provided by the Teamsters Security Fund included all firms within the Greater Bay Area* having warehousemen covered under the pension fund agreement. This listing includes each firm's name and address, as well as the number of its warehouse employees. While the ILWU listing does not include statistics on the number of employed warehousemen, union officials have stated that such information can be developed if the need arises. Officials of both the IBT and ILWU expressed considerable interest in the findings of the study and indicated their willingness to cooperate in any way possible.

However, it is doubtful that similar information could be obtained from union listings for the entire United States. A check with IBT headquarters in Washington and with the manager of the Central, Southeast, and Southwest Pension Agreement in Chicago, revealed that their records are not maintained in a manner similar to that of the West Coast.

## Equipment Suppliers and Engineering Consultants

There is a small, but growing, industry providing equipment, services, and consultation to the materials handling and warehousing market. Persons

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* Nine counties: Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, Solano, and Sonoma.

in this field offered expert opinion on expected trends in the technology of warehousing, which are discussed in Section IV.

## Field Visits to Warehouses

A sample of warehouses was selected to provide an overall view of warehousing functions in each of the geographical areas under study. Typical items discussed with management were: (1) policies and attitudes of management toward technological change; (2) descriptive, technical, and employment aspects of system changes; (3) future plans for mechanization, if any; (4) nontechnological factors contributing to labor force changes (e.g., centralization); and (5) availability of employment data.

Assurance was received in all cases that access to relevant data would be provided in the event of a second-phase study. However, on the basis of the descriptions given by management, it is difficult to ascertain the form and reliability of these data. Information appears to be very complete in some cases and fairly meager in others.

## Other Sources

This study has benefited from information developed in a recent SRI project in which a preliminary survey was made of U.S. markets for an automatic pallet retrieval system. One of the objectives of that study was to identify warehouses that are prime candidates for technological change. Since the scope of the project extended beyond the geographical confines of our five-state region to the entire United States, it is of value in assessing the impact of new technology on a sample of warehouses for the nation as a whole. Transcripts of interviews with management in the national sample were reviewed, and a listing of the installations visited by the project personnel is given in Appendix A.

# IV TRENDS IN WAREHOUSING

## Introduction

### Warehouses

As a class of business operations, warehousing constitutes the major part of the more general class of operations known as materials handling, and involves the receipt, storage, and movement of goods or supplies. It is a process or function rather than an industry, and, as such, it cuts across most--if not all--industrial classifications. There are few industries, except for the so-called service industries, that do not in some way require the storage and handling of materials or products. For the purposes of this study, the following terms have been used to describe various types of warehouses.

Distribution warehouse: receives, sorts, stores, and ships goods for distribution to outlets or ultimate users. Examples are found primarily in the wholesale industry, and include warehouses servicing multiple outlet retailers (e.g., mail order, department store, and food chains). Some manufacturers also maintain warehouses that function as distribution centers.

Manufacturer's warehouse: stores outgoing goods produced in an adjacent plant.

Public warehouse: provides clients with short or long term storage on a rental basis (e.g., household, general, and refrigerated goods; farm products).

Transfer terminal: sorts goods and changes carrier, generally entailing the breakdown of large shipments into smaller ones for reshipment.

### Warehouse Functions

Warehouses of the same type may vary greatly in their overall purpose and individual requirements, but they have numerous functions in common. Throughout the course of this research, we have considered the following functions as basic to the majority of warehousing operations:

Receiving: unloading of incoming products, including the checking, identifying, or recording processes used.

Routing: transporting and placing goods within a warehouse building complex.

Sorting: selecting and consolidating like products.

Storage: holding products in warehouse locations until required to fill orders.

Order-picking: retrieving required material from storage.

Order-assembling: assembling various items required by an order in one location, including packaging for shipment.

Shipping: transmitting and loading of orders into transportation systems.

Record-keeping: maintaining all information relating to transactions concerning an order.

## Automation and Mechanization

Our review of the literature and consultations with warehousing authorities indicate that much confusion exists concerning the definitions and usage of the terms automation and mechanization. For the purposes of this study, the following definitions were adopted as working terms:

Automation: the application of mechanical, electrical, or other nonhuman systems capable of making the routine decisions necessary to control powered equipment.

Mechanization: the application of powered equipment directly controlled by workers.

Manual: the application of human labor to operations, including the use of hand tools, but excluding the powered devices.

By restricting the definition of automation to its historical concept of nonhuman control systems, some of the confusion inherent in any attempt to describe various classes of warehouses has been eliminated.

It is not possible, within the limitations of this study, to enumerate mechanized warehouses. The vast bulk of installations fall between the two extremes of completely manual and completely automated operations, and individual functions may be manual, mechanized, or automated. Only by breaking down an operation into its individual functions can the degree of technological change be identified. Any definitive study should employ a method of analysis such as Professor James Bright's profile of mechanization.* A possible adaptation of his type of analysis to warehousing

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* Bright, James R., Automation and Management, Harvard University, Boston, 1958.

might be the use of three levels of mechanization: (1) fork lift trucks and relatively simple mechanical equipment; (2) conveyors and more advanced mechanical equipment; and (3) highly mechanized equipment, such as palletizers, stacker cranes, and traffic control devices.

The extent to which a warehouse operation can be successfully mechanized depends on a number of factors, such as volume of goods handled, sizes and shapes of articles moved, and diversity of product line. Most authorities agree that warehouses that are candidates for improvement by mechanization usually have the following characteristics:

Volume: with cased goods, 4,000 units per day or more.

Dimensions: shapes, sizes, and weights of goods adaptable to mechanized handling methods.

Diversity: relatively small number of different items, with 30 percent of items accounting for 70 percent of volume shipped.

## Factors Relating to Managerial Decisions to Mechanize

In addition to the prerequisites of mechanization listed above, a number of other conditions influence management's decision to mechanize a warehouse. These factors have been grouped in two broad classes: those tending to facilitate the decision to mechanize, and those tending to inhibit it.

### Factors Facilitating the Decision to Mechanize

In the more highly mechanized warehouses, the following factors were usually given as the prime motivations leading to a decision to mechanize: (1) a desire to increase productivity in order to handle the increase in volume of goods without an increase in the size of the labor force; (2) the need for more efficient utilization of available space; and (3) customer demands for prompt, dependable service and for accuracy in order selection. In some industries, reduction of order-picking error appears to be the largest consideration, since a single error generally doubles both the handling cost and the delivery time of an item. Additional benefits, such as reduced damage, waste, and pilferage, are also given serious consideration.

Successful mechanization of a warehouse inevitably means that more goods can be handled in a given number of man-hours than is the case in an operation in which manual labor predominates. As productivity increases, the number of man-hours worked will decline unless the volume of goods handled also increases.

In all warehouses in which highly mechanized equipment had been installed, management reported that productivity and volume had kept pace; in fact, in one instance it had been necessary to hire additional labor

to handle the increase in volume. It appears that as a warehouse increases its capability to handle additional volumes through mechanization, both production and sales likewise expand their capabilities for increased output.

None of the mechanized warehouses considered reduction in its current labor force as a desired outcome of the decision to mechanize. According to one representative of a major manufacturer noted for advanced concepts and designs of mechanized equipment: "As our experience with mechanization of warehousing expands, it is becoming more and more apparent that direct labor-savings are not foremost in the appraisal of feasibility."

The importance of labor force reduction as a factor in facilitating the decision to mechanize is a subject of some debate. Some authorities expressed the belief that reducing the employed labor force is of major importance to management when considering mechanization. However, results after mechanization are usually quite different from the benefits that were anticipated. The cost per item handled may be less, but the labor force may have increased because of the new work created by the installation.

## Factors Inhibiting the Decision to Mechanize

The high cost of equipment is perhaps the major deterrent to management's decision to install highly mechanized equipment. Furthermore, equipment installation in some warehouses would require new construction, and management believes that it cannot justify this additional expense. Hesitancy also results from the anticipated length of the payback period. Some of the more publicized failures to produce desired results further discourage acceptance of mechanized warehouses as sound and economically feasible operations.

Many informants reported a reluctance on the part of management to recognize that warehousing represents a potential area for cost reduction. Manufacturing management, in particular, seems to view the warehousing function as secondary to production as a cost factor. When seeking labor-saving methods, the focus is generally on the larger group of production workers, rather than on the relatively small warehouse labor force. In addition, labor-saving economies are more often directed at higher-salaried personnel than at the comparatively low-paid warehousemen. However, other informants reported that the more progressive and larger firms are demonstrating a new awareness of the relative importance of materials handling versus production costs. This change in attitude is evidenced by studies that show a steady increase in a systems approach to a manufacturing firm's entire operation--from the receipt of raw materials to the shipment of finished products.

In the smaller establishments, there is often a further deterrent to mechanization in the lack of a qualified engineering staff with a capability for systems analysis. Management frequently believes that it can

neither afford the expense of such high-salaried specialists, nor can it justify the employment of consulting engineering firms. Materials handling as a specialized field is a relatively recent development, and there is a current shortage of industrial engineering consultants who concentrate on warehousing. This is particularly true in the five-state western region, where only a few warehousing specialists are located.

## Trends in Mechanization of Warehousing

Variations in warehouse size, function, and equipment create a problem in deriving generalizations concerning mechanization of warehouses. Further variations by industry and region compound the difficulty.

### Variations by Size

Most authorities interviewed agree that installation of expensive mechanized equipment will be limited to the larger firms with sufficient financial resources to handle the initial expenditure. We were interested in determining what percentage of the total number of warehouses these firms might include. In this aspect of the research, the IBT pension fund list was a valuable source of primary data. This list includes all firms in the Greater Bay Area employing warehousemen covered under the trust fund agreement (estimated at 50 percent of all warehouses). The distribution of these firms by number of employees is given in Table 1.

The warehouses in the table can be divided into two broad groupings: (1) a large number of warehouses--90.8 percent of the total--each employing few workers; and (2) a small number of warehouses--9.2 percent--each employing many workers. Group 1 firms would not appear to be likely candidates for mechanization, primarily because--as the small number of employees indicates--they are low-volume operations. Group 2 seems more promising, since the larger number of employees suggests that they are high-volume operations.

### Variations in Unit Functions

The extent to which a warehouse can be mechanized varies greatly among firms, for nearly every warehouse is a unique operation with its own set of problems. The most effective approach to the study of warehousing systems is to divide the operation into unit functions, which calls for an application of the general concept of systems analysis and design.

In some cases, only one warehouse function can be effectively mechanized; in others, a more elaborate combination of functions can be mechanized advantageously. Those functions that appear to have the greatest potential for mechanization are sorting, order-picking, assembling, and routing.

Table 1

IBT UNION FIRMS IN THE GREATER BAY AREA BY NUMBER OF EMPLOYED WAREHOUSEMEN

| Number of Employees | Number of Firms | Percent of Total Firms | Cumulative Percent | Total Employees | Percent of Total Employees |
|---|---|---|---|---|---|
| 1-9 | 909 | 76.8% | 76.8% | 3,003 | 28.4% |
| 10-19 | 166 | 14.0 | 90.8 | 2,273 | 21.5 |
| 20-29 | 39 | 3.2 | 94.0 | 918 | 8.7 |
| 30-39 | 25 | 2.1 | 96.1 | 848 | 8.0 |
| 40-49 | 13 | 1.1 | 97.2 | 548 | 5.2 |
| 50-59 | 9 | .8 | 98.0 | 492 | 4.7 |
| 60-69 | 5 | .4 | 98.4 | 309 | 2.9 |
| 70-79 | 7 | .6 | 99.0 | 518 | 4.9 |
| 80-89 | 1 | .1 | 99.1 | 85 | .8 |
| 90-99 | 2 | .2 | 99.3 | 190 | 1.8 |
| 100-235 | 8 | .7 | 100.0 | 1,386 | 13.1 |
| Total | 1,184 | 100.0% | | 10,570 | 100.0% |

Source: Stanford Research Institute derived from IBT pension fund list.

Occasional examples can be found that involve the mechanization of one of these functions without regard for its relation to other functions. For example, an equipment salesman, untrained in the complexities of systems design, may encourage the purchase of a piece of equipment without considering its integration within the entire warehouse operation. The warehouse manager, who may be untrained in electromechanical techniques and without a supporting staff of skilled personnel, may encounter serious problems in operating and maintaining the unfamiliar equipment.

## Variations in Warehousing Equipment

Most of the warehouses visited or investigated operate with lift trucks and mechanical conveyors. It is exceptional to find warehouses with advanced equipment such as palletizers, automatic pallet retrieval systems, stacker cranes, and traffic control devices.*

Because of the highly individual nature of warehousing requirements, equipment must usually be custom designed to solve specific problems. The expense associated with procurement of such specialized equipment often serves as a deterrent to mechanization. Unless radically new equipment designs are developed soon, it seems unlikely that most industry groups will benefit from increased mechanization in the near future.

## Variations by Industry

Differences of opinion exist on which sectors of industry will be most apt to mechanize warehouses. Some authorities suggest that wholesaling in general is likely to consider mechanization more seriously than is manufacturing, since the wholesaler is primarily concerned with rapid movement of goods. Other authorities propose that manufacturers are the prime candidates for warehouse mechanization, since distribution appears to be the last frontier of cost reductions. As production processes become increasingly automated and as product differentiation become less variable, more attention will be paid to warehousing as a means of increasing efficiency.

Our general impression, based on a very rough index of consensus of authorities, is that food wholesaling and multiple outlet retailing may become the most advanced industries in terms of viewing mechanization as an avenue to increased efficiency in warehousing. Other industrial groups frequently suggested as potential candidates are:

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* See D. Oliphant Haynes, Materials Handling Equipment, January 1963, pp. 35-63, for a descriptive listing of warehousing equipment.

| | |
|---|---|
| Wholesalers: | apparel and dry goods<br>printing and publishing<br>metal and metal products<br>drugs and toilet articles |
| Manufacturers: | food processing<br>printing and publishing<br>apparel<br>alcoholic beverages |

## Public Warehouses

Because of the diversity of goods they must handle, public warehouses do not appear to be likely candidates for mechanization in the near future. In the five-state western region, they are usually filled with miscellaneous items of such variety that mechanized equipment lacks the flexibility to handle them.

Some authorities have predicted an eventual increase in public warehousing and a decrease in private warehousing. Should this change occur, it is possible that public warehouses will install mechanized equipment to serve large firms requiring additional floor space for storage of seasonal goods. However, the feasibility of mechanizing the public warehouse will probably continue to be marginal for some time to come.

## Transfer Terminals

Stimulated by the examples of mechanized systems installed in such agencies as the Railway Express, the U.S. Post Office, and military supply depots, some motor carriers of general freight have been investing in mechanized equipment. A Los Angeles transfer terminal is reported to be installing one of the most highly mechanized systems in the nation.

One authority stated that containerization (the consolidation of goods into a standardized container) represents the next significant advance in the transfer terminal industry. If this proves accurate, motor carriers may have to invest in containerization development to remain in a competitive position.

## Variations by Region

Warehouse mechanization is proceeding at a more rapid rate in the east than in the five-state western region covered in this study. Comments by nearly all the authorities interviewed and in the literature reviewed confirm this pattern of regional development.

Within the five-state western region, Hawaii and Alaska must be regarded as special cases because of their size, remoteness, and heavy reliance on air and water transportation of goods. Oregon and Washington are

relatively thinly populated, and are not expected to be in the forefront of mechanization. California most nearly approximates eastern trends.

## Warehousing in the Context of Physical Distribution

Information developed in this study suggests that it may be useful to view warehousing in the context of physical distribution, since decisions about improving warehouses are often closely linked to decisions about purchasing, inventory policy, transportation, data processing, engineering, packaging, shipping, warehouse location, and customer requirements. The literature on this subject generally combines these related functions under the concept of physical distribution.

Significant examples of elimination of warehouses resulting from reorganization of physical distribution have been reported in trade journals.

> General Foods eliminates 115 warehouses and now runs operation from 15 distribution centers (Dun's Review, January 1965).
>
> Borden's replaced 150 warehouses with 15 distribution centers (Food Engineering, August 1962).
>
> MacMillan replaces 6 distribution centers with 1 (Publishers Weekly, January 1959).
>
> Corn Products Co. . . . cutting down from 221 consignment warehouses to 16 distribution centers (Dun's Review, June 1963).
>
> Whirlpool Corp. has substituted 4 regional distribution centers for 12 warehouses (Dun's Review, June 1963).
>
> At one time . . . the Coleman Co. operated with 40 warehouses; now it has 17 regional distribution centers (Dun's Review, June 1963).

These examples may represent an increasing trend toward centralization of certain distribution functions, in which small and widely dispersed warehouses are replaced by larger, centralized warehouses (or distribution warehouses). This consolidation, by establishing warehouses of sufficient size and volume, may provide an opportunity to apply modern warehousing concepts and equipment.

## Improved Methods of Operation and Training

Some authorities stated that management has recently begun to look critically at warehousing as an area in which to increase productivity. These authorities also state that management's attention is focusing on

such factors as space layout planning, merchandise location systems, inventory control, and personnel training, rather than on mechanization. They believe that consideration and improvement of such factors should always precede mechanization, and in many cases would yield a much higher return on a smaller investment.

One authority believes that the increasing emphasis on management training programs will lead to a higher degree of sophistication in management policies and practices related to the training of the warehouse labor force. The University of Southern California offers a recurring one-semester course on techniques of materials handling for management personnel; in addition, related seminars are held frequently.

In a few instances, the warehousing function has profited significantly by training and supervision of warehousemen. The manager of a Los Angeles distribution warehouse is a strong advocate of training. He tries to create a highly skilled and motivated warehouse labor force through the use of careful recruitment and training methods. New workers are given an extensive and continuing training program designed to prepare and motivate them to upgrade their work. He believes that employee skills developed by these means, when combined with carefully designed methods of warehouse operation, can often eliminate the need for costly mechanized equipment. His own warehouse--although highly systematized--only uses a conveyor on one story of a multifloor operation.

A manager of another Los Angeles distribution warehouse, of similar type, size, and volume as the foregoing has installed a highly mechanized system, but has not paid the same attention to the personnel and training aspects of his operation. Both managers agree, however, that in approaching their mutual problems with contrasting solutions, they have achieved almost identical results in terms of productivity.

Two other respondents also agreed that warehouse management could achieve highly improved performances by the development of an effective training program. One stated that a skilled labor force could overcome the disadvantages of damage and error-making; the other stated that before considering installation of highly mechanized equipment, a firm must (1) do what it can to upgrade the available labor force and improve present methods of operation, and (2) determine what it can afford to invest beyond the expense of this improvement.

## Further Developments in Warehousing

Certain general developments, in addition to those discussed above, may significantly influence the warehouse of the future. For example, advanced application of computerized data processing, improved transportation, further developments in containerization, and matching of customer requirements with production schedules may curtail, or possibly eliminate, the use of some warehouses. In the ideal situation, the manufactured item would be shipped directly from the production line to the customer, without interim storage.

Other possibilities are: (1) the advancement of greatly expanded and cheaper air transportation; (2) the linking of a geographically dispersed network of production and warehouse facilities by computerized system employing dataphones or similar equipment; and (3) the increased activity of public warehouses as distribution centers for manufacturers and wholesalers.

## The Warehousing Labor Force*

Inquiries were made as to the availability of data concerning the labor force in all warehouses visited, and specific plant information was located in most of the firms. Inquiries were also addressed to other sources of information (e.g., trade and employer associations, equipment suppliers, engineering consultants, and labor union officials). However, as we have emphasized, little information was obtained concerning the total warehousing labor force in the five-state region.

### Occupational Classifications

A great deal of variance in job classification was found within the warehouses visited. Categories ranged from "general warehouseman" to "professional materials handler." Warehousing jobs are usually broadly defined. For example, the classification of general warehouseman is often applied to any worker within the warehouse operation, whether he performs manual functions or operates a mechanized vehicle. In some cases, collective bargaining agreements specify, not only the warehouseman's rate of pay, but the particular functions he may perform. In most cases, however, union controls over the variety of tasks that may be performed within a warehouse are minimal.

As discussed in Section III, no significant changes of job categories were found between the old and the revised editions of the Dictionary of Occupational Titles that would indicate obsolescence of warehousing occupations.

However, new job classifications may be created by innovations introduced. Since mechanized installations in warehouses are usually tailored to fit the individual warehouse function, significant changes in job content are likewise apt to be an individual adaptation to the particular method of operation.

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* Investigation conducted prior to the initiation of this study revealed that no reliable data existed on the national warehousing labor force. However, enough rough information was acquired to conclude that the number of persons employed in warehousing in the United States is not less than 400,000 and may be far greater. During the study, efforts were made to locate census data on the labor force in each of the five states being studied, but no data on the number of persons engaged in warehousing operations were found.

## Impacts and Displacement

All of the firms studied reported that there were no layoffs as a result of mechanization; any workers displaced as a result of equipment introduction were transferred to other positions within the plant. It seemed evident that management wished to avoid any displacement that could not be handled by transfer or through normal attrition.

One authority stated that it is not necessarily true that operation of mechanized warehousing equipment requires a more highly skilled labor force; in fact, the newly created job often calls for less skill. Where the job content is upgraded, he believes the present-day warehousing labor force usually has sufficient education and skills to find new work when displaced.

Union concerns with worker displacement were also evident. Officials of both West Coast labor unions (IBT and ILWU) are constantly on the alert for trends that indicate potential worker displacement, and, if such trends are found, the unions are quick to include them as an issue in subsequent collective bargaining.

Joint union-management investigations of warehousing in the San Francisco Bay Area have produced no evidence of layoffs due to technological change. A 1962 survey conducted in San Francisco by a joint labor-management committee on automation concluded that no significant displacement or reduction of manpower had been experienced in the warehousing industry as a result of mechanization. This conclusion has since been borne out by the fact that mechanization has not been a bargaining issue in recent negotiations.

No incidents of major displacement in the warehousing labor force were reported by suppliers, consultants, or other sources of information. Several authorities stated that warehouse employment is declining slowly, but it is because of nontechnical influences in the peripheral areas of distribution rather than from mechanization. In the Bay Area, for example, some geographical displacement has occurred as a result of warehouses moving from central city locations to the less populated suburban areas. In most cases, such movement is associated with improved warehousing design and materials handling methods.

Other factors responsible for the gradual decline in warehouse employment are centralization, transportation advancements, and such organizational innovations as improvements in warehouse layout, work methods, and merchandise location systems.

## Pace of Mechanization

We found no evidence to suggest that any revolutionary change will take place in the nature of West Coast warehousing in the near future as

a result of mechanization. In fact, all the evidence suggested that warehouse mechanization in the five state region will proceed at a gradual pace. However, technological change in warehousing is unlikely to advance at the same pace in all industries. Any estimates of the effects of such changes on employment must consider industrial variation as well as the other factors discussed above.

Some authorities predict that only the larger firms able to justify the expense of mechanization will install costly equipment. If this should be the case, the information developed from labor union data on the size of warehouse operations in the San Francisco Bay Area suggests that only a small percentage of concerns are potential prospects for mechanization.

Although no basic technological breakthroughs are predicted for warehousing in the near future, there is always the possibility that new developments may appear. Equipment suppliers are expected to be aggressive and competitive in developing new methods to cope with the problems of mechanizing individual warehouse functions. The pace of change could be accelerated by the speed of this development and the possible resultant cost reductions.

With the continuing emphasis on mechanized warehouses in trade publications and other literature, there is a possibility that more firms will follow the example of those that have mechanized. This could act as either an inhibiting or facilitating factor to mechanization, depending on the degree to which companies rely on careful systems analysis and design and achieve success in innovation. Most companies will probably wait until such experiments have been proved by other firms in their own industries.

## Appendix A

## SOURCES OF INFORMATION

### Organizations and Individuals

| Trade Publications | Person Interviewed |
|---|---|
| Distribution Age | Ronald Ray |
| Material Handling Engineering | Bernard Knill |
| Modern Materials Handling | Gordon Thomas |
| Western Materials Handling | W. E. Badgley |
| **Governmental Agencies** | |
| California Public Utilities Commission | Thomas Morley |
| California State Department of Employment | Don Mayall |
| | Paul Wildhofer |
| California State Department of Industrial Relations | Ray Schultze |
| Hawaii State Department of Labor and Industrial Relations | Teruo Yoshida |
| Hawaii State Department of Land and Natural Resources | David Butchart |
| Hawaii State Department of Planning and Economic Development | Ruth Brownell |
| Oregon State Department of Employment | T. Lynch |
| Oregon State Department of Planning and Economic Development | S. Fuqua |
| Santa Clara County Planning Commission | Robert Clark |
| Santa Clara County Tax Assessor's Office | Dwight Mathiesen |
| | Verne Keithley |
| U.S. Department of Labor | |
| Bureau of Employment Security | Margaret Thal-Larsen |
| Bureau of Labor Statistics | Max Kossoris |
| Occupational Analysis Center | Kenneth Bohn |
| Washington State Department of Employment | Otto Johnson |
| Washington State Department of Planning and Economic Development | Judd Wenderly |
| **Other Agencies** | |
| Department of Economic Research, First National Bank of Hawaii | Thomas Hitch |
| Department of Economic Research, First National Bank of Seattle | Minor Baker |
| Department of Research, Port of Portland | Bill Dirker, Andy Miller |
| Department of Trade, Port of Seattle | Henry Levinger |

| Other Agencies (cont.) | Person Interviewed |
|---|---|
| Economic Research Center, University of Hawaii | Thomas Ige |
| Portland Chamber of Commerce | Allen Stokeld |
| Portland Public Docks | Fritz Timmer, Vernon Smith |
| San Jose Chamber of Commerce | Robert Bye |
| Seattle Chamber of Commerce | Dennis Givens |
| **Trade Associations** | |
| American Warehousemen's Association | Donald Horton |
| Conveyor Equipment Manufacturers' Association | R. C. Sollenberger |
| Materials Handling Institute | L. W. Shea |
| National Association of Refrigerated Warehouses | Richard Powell |
| National Motor Freight Traffic Association, Inc. | F. G. Freund |
| National Wholesale Druggists' Association | William Ford |
| U.S. Wholesale Grocers' Association, Inc. | Harold Smith |
| Western Association of Food Chains | Robert Palmer |
| **Employer Associations** | |
| Bay Area Distributors' Association | Ray Smarden |
| Federated Employers of San Francisco | Robert Keller |
| **Labor Organizations** | |
| International Brotherhood of Teamsters | John Hughes, Bruce Poyer, Bill Williams |
| International Longshoremen's and Warehousemen's Union | Charles Duarte, Lincoln Fairley |
| **Equipment Suppliers** | |
| Air-Mac, Inc. | Stanley McDonald, John Ulmer |
| Alvey Ferguson | Howard Werle |
| Chapson Brothers | William Clark |
| Food Machinery Corporation | John Furrer |
| Foster Equipment Company | Fred Cordes |
| Linc Belt Co. | Richard Cornelius |
| Matthews Conveyor | William Peppard |
| Rapistan, Inc. | Thomas Stewart, H. M. Ramussen |

| Engineering Consultants | Person Interviewed |
|---|---|
| Allan Gall and Associates | Allan Gall |
| Drake, Sheahan, Sweeney and Hupp | John Sheahan |
| Keldon and Associates | Donald Badziong, Jack Timmer |
| Semco, Sweet and Mayer | William Semco |
| United Shippers | Clifford Van Duker |

| Warehouses | |
|---|---|
| Beech Nut Life Savers | San Jose, California |
| Broadway Stores | Los Angeles, California |
| California Canners and Growers | San Jose, California |
| Consolidated Freightways Terminal | Portland, Oregon |
| Continental Can Company | San Jose, California |
| Dole Corporation | Honolulu, Hawaii |
| Fred and Meyer Stores | Portland, Oregon |
| Hotpoint of Hawaii | Honolulu, Hawaii |
| International Business Machines | Campbell, California |
| Jantzen, Inc. | Portland, Oregon |
| Jennings Radio Manufacturing Corp. | San Jose, California |
| Kaiser Aluminum Foil | Permanente, California |
| Kockos Brothers, Ltd. | Union City, California |
| Libby, McNeil & Libby | Sunnyvale, California |
| Market Wholesale Grocers | Modesto, California |
| May Company | Los Angeles, California |
| Modern Ice and Cold Storage | San Jose, California |
| Montgomery Ward | Oakland, California |
| Moore Business Forms | Sunnyvale, California |
| Northwest Publications | San Jose, California |
| Omark Industries, Inc. | Portland, Oregon |
| Palo Alto Commercial Warehouses | Palo Alto, California |
| Pepsi-Cola Bottling Co. | Santa Ana, California |
| Port of Seattle | Seattle, Washington |
| Red Line Warehouses | San Jose, California |
| Schlitz Breweries | Honolulu, Hawaii |
| Thomas Transfer and Storage | Palo Alto, California |
| United Air Lines Terminal | San Francisco, California |
| U.S. Naval Supply Center | Alameda, California |
| Waterway Terminals | Portland, Oregon |
| Western Electric Company | Seattle, Washington |
| Wilhelm Warehouse Company | Portland, Oregon |
| Zellerbach Paper Company | Seattle, Washington |

Other Warehouses*

| | |
|---|---|
| Allegheny Ludlum | Pittsburgh, Pennsylvania |
| Armco Steel Corporation | Middletown, Ohio |
| Basic Refractories Division, H. K. Porter | Pittsburgh, Pennsylvania |
| C&H Sugar Refining Corporation | Crockett, California |
| Chevrolet Motor Division, General Motors Corporation | Flint, Michigan |
| Cloverleaf Cold Storage | Sioux City, Iowa |
| Consumer Electronics Division, Philco Corporation | Philadelphia, Pennsylvania |
| Fisher Body Technical Center | Warren, Michigan |
| Gallo Wine | Modesto, California |
| Harvey Aluminum Company | Los Angeles, California |
| Hotpoint Division, General Electric | Cicero, Illinois |
| Jewel Tea Company | Melrose Park, Illinois |
| Lily Tulip Cup Corporation | Riverside, California |
| Polaroid Corporation | Cambridge, Massachusetts |
| NuLaid Foods Division, Pacific Growers Inc. | San Leandro, California |
| Penn Fruit Company | Philadelphia, Pennsylvania |
| Raymore Corporation | Sioux City, Iowa |
| Reliance Electric and Engineering Company | Cleveland, Ohio |
| Reliance Steel and Aluminum Company | Los Angeles, California |
| R. J. Reynolds Company | Winston-Salem, North Carolina |
| Sunkist Growers, Inc. | Ontario, California |
| United Parcel Service | Los Angeles, California |
| Wean Manufacturing Company | Warren, Ohio |
| Western Electric Company | Kearny, New Jersey<br>West Chicago, Illinois<br>Winston-Salem, North Carolina |
| Westinghouse Electric Company | Muncie, Indiana<br>Sharon, Pennsylvania |

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* The category Other Warehouses refers to warehouses that were visited in connection with a separate SRI study on automatic pallet delivery systems. Although that study covered the entire United States, it was of value in assessing the impact of new technology on a sample of warehouses for the nation as as a whole.

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